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ABSTRACT

A visit to the natural history museum is part of many pupils' educational program. One way of investigating what children learn about animals is to examine the mental models they reveal through their talk when they come face to face with animal representations. In this study, representations were provided by: (1) robotic models in a museum; (2) preserved animals in a museum; (3) live animals exhibited in a zoo. By recording pupil talk in these settings and then analyzing the content of the talk for comments about the anatomy of animals, their behavior, habitat features and so on, both similarities and significant differences are revealed. Hitherto, little work has been done about such school visits. The collected conversations with live, museum, and robotic animals were analyzed using a systemic network. Robotic animals followed by museum animals elicit more comments than do live animals, and the reality of the images viewed according to the comments of the children are discussed. The implications for zoological education are also discussed. (Contains 17 references.) (Author/CCM)

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Images of animals; Interpreting Three-dimensional, Life-sized 'Representations' of Animals- zoo, museum and robotic animals

Abstract

One way of investigating what children learn about animals is to examine the mental models they reveal through their talk when they come face to face with animal representations. Moreover, a museum's story is told mainly through its exhibits. However, this story may not be 'read' by visitors, who come with their own knowledge and understanding, and read a different one which makes sense to them and builds on what they already know. A visit to the natural history museum is part of many pupils' educational programme. One way of investigating what children learn about animals is to examine the mental models they reveal through their talk when they come face to face with animal representations. In this study, representations were provided by (a) robotic models in a museum; (b) preserved animals in a museum, c) live animals exhibited in a zoo. By recording pupil talk in these settings and then analysing the content of the talk for comments about the anatomy of animals, their behaviour, habitat features and so on, both similarities and significant differences are revealed. Hitherto little work has been done about such school visits. The collected conversations at live animals, museums and robotic animals were analysed using a systemic network. Robotic animals followed by museum animals elicit more comments than do live animals and the reality of the images viewed according to the comments of the children are discussed. The implications for zoological education are discussed.

Introduction

Animals are part of our environment and form some of the first words in our vocabulary (Risland, 1946). Indeed, children learn about animals in a whole variety of ways. Direct observations of wild animals, pets and farm animals can be important, while toys- soft representations and farm/zoo animals, books, films and schools play significant roles. Zoos and museums which children have been visiting ever since these establishments opened their doors to the public have the potential to assist children in constructing their mental model of animals.

Zoos are places where *learning conversations* take place (Lucas, McManus, & Thomas, 1986). Nearly all of these conversations at animal exhibits are about animals (Tunnicliffe, 1995). Furthermore, parents state that they take their offspring to the zoo to "learn about animals" and to see or experience the "real animal" (Hill, 1971; Rosenfeld, 1980:39).

Despite their potential educational significance that which animals in zoos and museums cause visitors to say remains under-researched. Rosenfeld (1980) asked families about their zoo visit and came to the conclusion that these leisure visits contained overtones of learning, albeit the learning was of the everyday knowledge about exotic animals. Taylor (1986) analysed the questions visitors composed, wrote down and posted to the management via a special posting box while Hensel (1987) analysed the content of family conversations

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generated in an aquarium. Birney (1986) compared the recollections and learning of groups of 5th grade pupils at live animals in zoos and at preserved animals in museums. She found that the zoo visit generated far more affective responses to the specimens than did the museum specimens. However, I have been unable to find any published information about the responses of visitors to robotic animal models despite the increasing international prevalence, and apparent popularity amongst visitors, of such models, except for work I have published (Tunnicliffe, 1995; Tunnicliffe, 1999, Tunnicliffe in press)

Do people have to see the 'real thing' in order to learn about animals, and, if not what do they mean by 'real'? In a zoo, a viewer does indeed see a "real animal", albeit one that usually exists in an artificial setting without any prey, predators or other natural threats. Hence the zoo animal is yet another type of image, live but represented in a human constructed frame and constrained by this very design. The design of an exhibit sets a context in which the animal is seen and this artificially created surround helps form the image of the animal in the mind of the onlooker. There are several alternatives to live animals as exhibits. Those commonly used are museum or taxidermically preserved animals and models of animals made from glass fibre or other materials. Such replica models can be static or animatronic (robotic) models which move to a certain preplanned degree. These three dimensional representations of animals may be life sized, magnified or reduced in size. The models attempt to illustrate firstly the salient anatomical features of the living animal and secondly models of animals also seek to portray certain characteristic behaviour through either, for static models, the positions in which the animals are exhibited together with relevant associated artefacts and biofacts which illustrate the natural environment within the exhibit. Dioramas are the peak of such static exhibits. It is only more recently that certain museums have begun to provide robotic animals in their exhibits. Such exhibits can be popular with children but they differ in several crucial respects from living specimens (Tunnicliffe, 1996b). In particular, robotics move in a predictable and stereotypic fashion. Some exhibits are a combination of a taxidermic specimen with some simple movement. For example a swamp exhibit in Los Angeles Natural History Museum contained a taxidermically preserved duck whose head moved through the use of a motor. It is more usual that robotic or animatronic specimens are constructed from modern material such as latex over a steel frame with movable joints and operated by a motor.

To a large extent, visitors to museums let the exhibits set the agenda rather than bringing one with them (Hilke, 1988) but they interpret and talk about what they see through their own existing understanding (Tunnicliffe, Lucas, & Osborne, 1997). Whilst museum animals can be of key importance for the zoological education of children (Tunnicliffe, 1996a) they, like zoo animals are seen - as an image- within a context provided by the designer of exhibits who thus again influence the image which contributes to the mental model of the child. How do visitors respond to these various types of animal exhibit?

Purpose of this Study

I have long been interested in what children notice and potentially learn about animals. One way into exploring these topics is to examine the mental models that children reveal through their talk when they are faced with several different types of representations. In this study these representations are provided by (a) robotic models in a museum; (b) preserved animals in a museum c) animals in a zoo, in constructed exhibits.

Mental models may be viewed as representations of an object or an event. The process of forming and constructing models is a mental activity of an individual or group (Duit & Glynn, 1996). A mental model is an individual's personal knowledge of a phenomenon – in this case, of animals. The personal knowledge of the viewer faced with a representation of an animal will have both similarities to and differences from scientifically accepted knowledge, namely such things as the taxonomic position of the animal, its significant morphological features and so on. Viewers use their existing mental models as referents, and learning is about extending an existing mental model by utilising new information (Johnson-Laird, 1983).

The comparatively few data that exist suggest that, when children view animals, they identify certain striking features of the organisms. In particular, they notice anatomical features – such as the dimensions of the animal, its shape and its colour – and comment especially on its front end, on its legs, on other disrupters to its outline and on any unfamiliar organ (Tunnicliffe, 1995). These striking features become the defining ones for the children's constructions of animals and become incorporated in their mental models of different kinds of animals. The features of an animal which are the defining ones for a child can be revealed by obtaining representations by the child of specimens which the child has viewed. These representations may be written descriptions, oral descriptions, drawings or three-dimensional models.

Methodology

The data at the live animals and at the preserved animals were between 1992 and 1994 at London Zoo and the Natural History Museum London. The robotics data were collected between 1993 and 1997 at two separate dinosaur exhibits in the Natural History Museum in London, UK. One of these exhibits was of a single robotic – a small animated dinosaur – placed in a transparent tank at the exit of the main gallery. This exhibit had neither labels nor any accompanying information. The model was programmed to make a sequence of movements in a regular cycle, stretching one of its back legs, moving its tail, opening its eyes and breathing. Its aim was to stimulate inter-visitor discussion about similarities between the dinosaurs and modern reptiles. The other much larger exhibit occupied the width of the gallery at the end away from the entrance. The visitors came from the mezzanine walkway down a slope as they viewed the diorama and ended at ground floor level. The area was darker than the rest of the gallery. It contained a total of four dinosaur robotics: three small meat-eaters (*Deinonychus*) attacking one larger herbivore (*Terontosaurus*). These four models were set in a detailed reconstruction of the presumed habitat and were accompanied by labels and a brief explanatory text.

Aside from these dinosaur robotics, the majority of the preserved animals which the groups viewed in the museum were traditional, taxidermically preserved animal exhibits within a glass exhibition case. These cases were either free standing, enabling the children to move around the animal, or located against a wall so that the animal could be viewed only from one direction. Some school groups visited the three African dioramas created by Roland Ward which replicate naturalistic African scenes as well as displaying a realistic exhibit of mixed species. A few exhibits, such as the elephants and the model of the blue whale, both in the Hall of Mammals, were not enclosed in glass. Most of the exhibits had few if any accessory items which give clues about the natural habitat. This absence of habitat clues was most apparent in the free standing exhibits. Clues were more frequent in the wall exhibits where there was a backdrop but were most prevalent in the dioramas.

The 38 primary schools (with a total of 69 classes) with whom the work was conducted agreed to be part of the study. The pupils were aged between 3 and 12 and were not accompanied by museum staff, solely by their teachers and other adults (e.g. parents assisting the teacher supervise the pupils on their trip). Unsolicited conversations heard in the museum were audio tape-recorded, transcribed and then analysed. In all, approximately 35 hours of children's conversations were tape-recorded and transcribed. This resulted in a total of 1288 *units of conversation*, 422 of them at the robotics and 407 of them at the conventional preserved specimens and 459 at zoo aniamls.

A unit of conversation was defined as beginning when a group started talking at an exhibit and concluding when they stop talking. If the group stopped, moved on then talked again at the same exhibit but in a different position the conversation was counted as a separate unit. These units provide the raw data of this study. For the purpose of illustration, here is a typical unit of conversation which took place between two 7 year-old girls looking with an adult at one of the robotic exhibits:

Girl 1:	Look! It's moving. That's a *Tyrannosaurus*.
Adult:	No, it's not. It's *Tectonosaurus*.
Girl 1:	What is it Camilla?
Girl 2:	Look! At its neck.
Adult:	The big one moved its leg then. I don't think it's quite dead.
Girl 1:	Look at its neck.
Teacher:	Ugh!

First, all the transcribed conversations were read through to get a feel for the sense of the dialogues. Then, repeated listening allowed each comment within a unit of conversation to be coded into one or more categories. This coding into categories was done according to a systemic network. A systemic network is a type of analysis that changes qualitative into quantitative data and was developed from the work of Bliss, Monk and Ogborn (1983). One advantage of systemic networks is that by ending up with quantitative data they allow standard statistical analyses to be carried out, as is done below. Chi-squared tests can be used, rather than means and standard deviations, as the data are discontinuous.

In the study reported here, a total of 74 categories were used to construct the systemic network *part* of which is shown in Figure 1. (The full network is provided in Tunnicliffe (1995) and is available from us but runs to several pages.) Here, a bar, [, indicates that a comment falls into one of two exclusive categories or groups of categories, whilst a bracket, {, indicates one of a number of categories into which a comment may fall. Within each unit of conversation, each category is only recorded once, however often comments fall into it. Various other descriptive demographic data such as the types of animal observed and the type of adult accompanying the group were also recorded.

The first contribution from girl 1 in the above unit of conversation was classified as follows: The "Look!" is coded as 71 which refers to *ostensive comments*; the "It" of "It's" is coded as 21 which refers to *model animal exhibit references*; "moving" is coded as 35 which refers to *movement*; "That's" is coded as 24 which refers to *direct statements of identification*; and "a *Tyrannosaurus*" is coded both as 56 which refers to *scientific and common names* and as 64 which refers to *misclassifications* [since the model was in fact, as the adult accompanying the party subsequently stated, that of a *Tectonosaurus*].

The first contribution from the adult is simply coded as 12 which refers to *own opinions* and here is the coding for the statement "No, it's not." Because, within each unit of conversation, each category is only recorded once, however often comments fall into it, this is the only new coding for the adult's first contribution since "It's *Tectonosaurus*" would be coded as 24 and 56 [the adult's identification was correct].

In this way, the coding for each unit of conversation was gradually built up. For example, the reference to "neck" by the second girl was coded as 43 which refers to *head body parts* (see Figure 1); while the references to "big" and "leg" by the adult were coded, respectively, as 50, which refers to *sizes of body parts* (see Figure 1), and 48, which refers to *locomotory body parts* (see Figure 1).

Systemic networks are hierarchical and the four major categories of the systemic network used here were:

- Management and social comments which were comments to pupils (whether from an adult of other pupils) about getting a move on, behaving appropriately and so on.
- Exhibit-focused comments which were about labels, settings and so on.
- Exhibit access comments which were about finding and locating the animals.
- Animal-focused comments which were about the animals.

Animal-focused comments were allocated to one of six subordinate groups, namely:

- Interpretative comments which were questions, statements such as "I know" and "This is..." and anthropocentric comments or references to the topic from school or home.
- Affective comments which included emotive responses such as "Ah!" and "Ugh" as well as comments about such things as animal welfare.
- Environmental comments which referred to a natural habitat or endangered status of a species.
- Body parts comments which are comments about an animal's structure (see Figure 1).
- Comments about the animals' behaviours which included the position of the animal in its enclosure and any attention attractor behaviour which attracted the attention of the visitor, such as mating or fighting.
- Comments about the animals' names.

For each conversation unit the appropriate terminals were identified. If at least one instance of terminal use was identified the code 1 was entered in the appropriate cell of a data sheet. The numbers at the right hand side of Figure 1 refer to the terminals of the body parts part of the network.

Results

The contents of the conversations that were generated at the Natural History Museum by primary school groups at the two different types of animal exhibit are shown in Table 1. This table shows that there are both interesting similarities and interesting differences between the conversations.

In terms of similarities, it is clear, for a start, that virtually all the conversations (97% at the preserved animals and 95% at the robotic models) include interpretative comments. Examples of this type of comment are "Are they real?", a teacher asking "Which one makes the loudest noise?" and a statement about a robotic dinosaur from a 6 year-old boy, "It's got to be real because it moved". In addition, most conversations (61% at the preserved animals and 73%

at the robotic models) include comments on the specimens' anatomy . For example, a 10 year-old boy remarked about the meat-eating predator dinosaurs, "They use their claws", and a 7 year-old boy commented about the dying *Terontosaurus*, " ... that big thing, his leg keeps moving" [though "moving" is a behaviour comment]. Equally, most conversations (66% at the preserved animals and 72% at the robotic models) included management / social category comments. For example, a teacher telling her group, "Can you move down?" and a 12 year-old girl urging her companions, "Come on!".

However, there were also some very marked differences between conversations at the preserved animals and the robotics. In particular, the preserved animals generated far more naming comments (85% versus 42%) while, as might be expected, the robotics generated many more comments about behaviour (66% versus 37%) and about whether the animals were real/alive (38% versus 15%).

Table 2 shows in more detail the analysis of the conversations that contained animal-focused comments. It is apparent that the reason why robotics generate more comments about behaviour is principally because they generate far more comments about locomotion (59% versus 4%) and food (30% versus 7%). In addition they generate more attention attractor comments, which is not surprising because the models were moving and these movements attracted the attention of the visitors.

Similarly, Table 2 shows that names were much more likely to be used at the preserved animals. Each of the preserved animal exhibits had a different type of animal in contrast to the dinosaur exhibits which were of the same kind of animal – dinosaurs – and where there were only three different dinosaurs, one of which was unnamed. Fewer mistakes were made when identifying the dinosaurs. Again, this is not surprising as there were only two named dinosaurs. Fewer comments were made comparing the dinosaurs to other creatures, and most of these were likening the models seen to types of dinosaur known, particularly *Tyrannosaurus*.

The content of conversations at live animals in the zoo are shown in Table 3 and 4 where they are compared with the comments made at the robotic models. As the data reported in Table 3 and 4 show, school groups that view live animals and the animated models have a similar focus about exhibit access, management and social topics, other aspects of exhibits such as labels, interpretative comments, and comments about body parts. It is surprising that comments about the environmental aspects are similarly low, in view of the considerable efforts which the zoo put in to disseminating the conservation message, one not explicit but implicit within the dinosaur exhibits. In the case of both school groups the rationale for the visit is at last partially educational and the significant differences in the knowledge source comments between the two groups is interesting and perhaps cause for concern. In part the data may reflect the affect of the ambience of the surroundings upon the groups, the museums being perceived as a site of learning. However, the results may be indicative or an attitude amongst schools that the zoo is predominately an experience of a social nature with some observations of animals. The very focused nature of the dinosaur exhibits may direct the attention of the groups to the particular aspects of the exhibits that the designers considered salient, the visitors receive the message and discuss it, whereas in the zoo the explicit And inherent messages of the exhibits are largely unreceived.

It is an unexpected observation that the models elicited a higher proportion of conversations that contained affective comments when it is borne in mind that the notion amongst teachers and zoo educators is that the predominate topic of conversation amongst children in zoos is affective comments, and we have seen that this is so within farms (Tunnicliffe, 1995). The type of comment was either :

- dislike at the exhibit, as for example in the following exchange between two year 2 boys:

  Boy 1: Oh it's neck!'

  Boy 2: Ergh. Gross!'

- or more restrained comments, illustrated by the following remark from a chaperone:

  Boy: Urgh, Mum! Look, its neck's torn

  Adult: It's not very nice is it?

- or anthropomorphic type of interpretation:

  Adult: Isn't it a shame? The poor thing is hungry.

  A year 1 child: They didn't mean to do it [kill and eat the large dinosaur]

However, in the comments generated by school groups, it is not unexpected that the groups remark about behaviour of both types of animals specimens that move (Table 3 & 4), because the animals are either noticed mostly through their movements which draw the eye to the action or sometimes by the setting of the animal within the exhibit. Nor is it surprising that more comments about behaviour occur at least once in more conversations at animated models because the movements are predictable, sequenced and repeated. Furthermore, one of the focal points of the dinosaur diorama are the noises. It is a bi-sensory exhibit in terms of the number of senses that may be used to perceive it. Sound was an important criterion in children's assessing whether an object were living and perceiving an exhibit by a sense other than sight seems to lead to a comment because the experience is out of the ordinary. Live aniamals make noises infrequently and unpredictably.

Discussion and Implications

The specimens in the museum and zoo are not presented to an individual but are there for the individual, or group members, to select to view if they so choose. Because the museum animals are not moving something else has to catch the attention of the visitors. Moreover, the setting in which the animal image is exhibited also contributes to the image which the children construct from their visit. The museum experience is, in that sense, impersonal and optional. Robotics tell a clear, but short, story to which children typically attend closely. The movement of the robotics catches the attention of the visitors, a similar behaviour exists when visitors look at live animals and on some occasions the noises of the exhibit were the feature that took the visitor's attention in the first instance. On the other

hand, the preserved animals tell a more complex but less authoritative story. Pupils may either attend whole-heatedly to this or may combine it with their own story or stories, using visual (and possibly other, e.g. auditory) cues provided by the specimen combined with their own memories and/or imagination. Only rarely were occasions noted in the museum when teachers or other adults guided pupil learning. Likewise, in the zoo, the animals in their constructed surrounds are available for viewing if the visitor so chooses.

Few pupils mentioned the environment in which the animal lived in the wild nor did they speculate about this discussing what it might be from the physical features that they could observe. Few teachers or chaperones elicited such information or cued the pupils into such a train of thought. The conversation with Nigel at the camel reported above is a very unusual one, they type of which rarely occurred in the transcripts I collected. Research has suggested that few pupils have such an integrated understanding of environments (Brody, 1994; Strommen, 1995).

The museum animals present an image which contains clues to their identity, behaviour, adaptations and habitat. These are conceptual clues which children sometimes use to talk about imaginary scenes in which the animals exhibit behaviours. Such stories are often prompted by the background to the exhibit in a museum. Thus in the museum the perceptual clues provided by the exhibit give children a *framework* for a story of their own making.

Similarly, the moving robotic animals provide a strong story line which children tell, but they may also embellish it and provide their own interpretations: for example, at one of the robotic exhibits a pupil interpreted the smaller carnivores eating the larger herbivore as babies eating their "Mummy". Likewise the live animals tell a story if the visitor can read what the exhibit and the animal are telling. However, the emotions elicited by the live animal and its actions and particular attracting anatomical features tend to be the focus of the conversations and not any ' message' from the exhibit.

To a science educator, many of the conversations suggest ways in which children's scientific knowledge and understanding could valuably have been enhanced. For instance, on one occasion a group of 8 year-olds were looking at a model of a shark. One boy remarked that it was big and the accompanying adult echoed this observation by saying "It is a large one". Another boy then interjected "That blue whale is gigantic" and a girl then said "It's that big, that blue whale!". A boy then remarked "It's enormous" and another boy suggested "It's 18 elephants long!". "You think that?" asked the adult – but here the conversation lapsed at just the point where some scientific teaching about size or adaptation could have been introduced by the adult.

On some occasions, adults who accompanied the children did ask scientifically appropriate questions, though these were rarely pursued in any depth. For example, in front of a preserved camel one 8 year-old boy was asked by his teacher what the animal was. "Camel" the boy replied, correctly. "What sort of place would you expect to find that living, Nigel?" asked the teacher, to which another boy replied "I know Sir, a zoo!". The teacher agreed that it might be in a zoo but then asked them to suppose that the camel was living in the wild – where would it live? He urged the boys to look around the exhibit for clues. Nigel answered "Sand, a desert" to which the teacher replied "That's right".

The conversations analysed here suggest that far less scientific learning takes place than could be the case. Rather than being taught much in front of the specimens, children and their chaperons simply use their everyday knowledge and understanding to interpret what they see and to allocate everyday names using anatomical clues as their guide. The baseline of content provided by this study can be used to develop the science education offered within museums and schools by both museums and schools so that a progression in content of observations is developed. The progression must start with the everyday observations which the children bring to encounters with these representations of animals and build to include more formal accepted biological understanding.

One problem noted was that some adults accompanying school groups felt uncomfortable at their lack of appropriate knowledge. For example, while looking at some reptile models in the museum, one 8 year-old boy remarked that there were babies in the eggs. Another child added that the animals had green teeth and began to ask a question. At this point, however, the adult hastily interrupted by saying "We'd better go and find everyone else". The issue of the preparation which adults accompanying pupils on out-of-school visits is an important one.

More positively, some teachers did relate what was seen to school work. At an echidna (hedgehog-like, egg-laying mammal) preserved exhibit, a teacher asked her 6 year-old pupils whether they remembered the story which they had read together at school in which a man kept an echidna, and pointed out to the pupils that here was an actual echidna at which they could look. Indeed, this teacher did not just elicit pupil observations but used them to develop a teacher-learner dialogue. Later at an exhibit of a polar bear, a boy made a typical remark "Look at its claws!", to which the teacher responded by asking how many claws there were. The boy replied "One, two, three, four, five and he is all furry. Are there any polar bears in Iceland?" and there was a conversation about the geographical location of the habitat.

All kinds of three-dimensional representation discussed here – preserved animals in museums live animal in the zoo and robotic models in museums– provide the learner with opportunities to see anatomical features more fully than is the case with two-dimensional representations whether moving (as in films) or stationary (as in books). The museums images provide a far better opportunity than do the live animals because their position can be guaranteed and any exhibit artefact which draw the attention of the visitor to salient features are certain to be repent. Whereas the live animal may not even be visible to viewers when they reach the exhibit. Such opportunities give a teacher the chance to discuss these anatomical features and introduce those which are used by zoologists in categorisation. Similarly, three-dimensional representations, especially robotics and carefully positioned preserved specimens, provide clues about characteristic behaviours which the children may pick up or the teacher can extend.

Knowing to which features of an animal pupils naturally attend, makes it easier for a teacher to decide how to build on such initial interest to secure appropriate scientific knowledge through suitable questioning and other activities. Teachers, including those whose first specialism is not science, may benefit from realising that, as a fairly safe generalisation, it is the anatomical features of three-dimensional, life-sized representations that children first notice and comment on. Developing greater precision in observation, including anatomical observation, is a worthy aim of science education. But it is only one such aim.

To achieve greater depth of understanding in their pupils than is often the case teachers need themselves both to have a secure biological knowledge – so that they know, for example, what are the biologically significant features that characterise dinosaurs and mammals and the range of habitats in which such organisms are found – and to have the ability to teach their pupils to observe carefully and to extend their thinking. Trips to museums and zoos are of educational value, but not simply as "days out". It is possible for such trips both to be enjoyable and to provide unique learning opportunities. In the same way, animals (whether preserved or, where possible, living) brought into school can provide an enjoyable and different learning experience which enables pupils to use their own previous knowledge and experiences about animals to aid the development of their further understanding.

Well designed and constructed 3-D robotic models replicate a short period in time of the life of the animal(s) portrayed. However, robotic exhibits differ in several crucial respects from those of museum animals which do not move. Robotics move, but unlike live animals, they do so in a predictable, repetitive fashion but their movements can enhance the message the exhibitors want to convey, unlike the unpredictable messages given by real, live animals.

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Table 1

Comparison between the Number of Units of Conversations[a], n, of School Groups at Preserved Animals and Models (Major categories). Percentages are shown to Facilitate Interpretation but all Chi-squared (c^2) Tests are Carried out on the Raw Data, i.e. values of n

Category	Preserved animals n= 407	Preserved animals %	Robotic models n = 422	Robotic models %	c^2
Management / Social	270	66	304	72	3.2
Exhibit access	219	54	239	57	0.7
Other exhibit comments	220	54	173	41	14.2**
All anatomical comments	243	61	309	73	17.0**
All behavioural comments	152	37	363	87	208.6**
All naming comments	344	85	176	42	162.4**
Affective attitudes	158	39	229	54	19.9**
Emotive attitudes	145	35	199	49	11.4**
Interpretative	395	97	400	95	2.7
Real / alive[b]	65	15	170	38	60.3**
Knowledge source[c]	296	72	329	78	3.0
Environment	45	11	19	5	12.5**

** $p < 0.005$

[a]In all tables, the data refer to units of conversations that contain at least one comment in a given category. The categories are not mutually exclusive so percentages in sub-categories may add up to more than 100%.

[b]Comments in this category were ones which questioned or discussed whether the animal was real and alive.

[c]Comments in this category were where group members referred to the source of their knowledge. Such comments were predominantly personal using statements like "I think that..." or "I know that...." or asking questions of others. References to books, displays and other sources of information were rare.

Table 2

Comparison between the Number of Units of Conversations of School Groups at Preserved Animals and Robotic Models (Animal-focused Comments)

Category	Preserved animals $n = 407$	Preserved animals %	Robotic models $n = 422$	Robotic models %	c^2
All anatomical comment	243	61	309	73	17.0**
front end	67	17	113	27	13.0**
dimensions	198	49	173	41	4.9
unfamiliar	67	17	59	14	1.0
disrupters	39	10	162	38	93.7**
All behavioural comments	152	37	363	87	208.6**
position	69	17	80	19	0.6
locomotory	40	4	249	59	220.6**
food-related	28	7	127	30	73.5**
attention attractors	63	16	182	43	76.1**
All naming comments	344	85	176	42	162.4**
label	297	74	147	35	121.2**
category	232	57	85	20	119.2**
compare	166	41	41	10	106.8**
mistake	23	6	6	1	na[a]

** $p < 0.005$ [a]Not applicable. Cell size too small.

Table 3.

Comparisons between content of conversations of school groups at live animals in the zoo and the animated models

	zoo	n=459	dinosaurs	n=422	c 2 1df	Probab-ility	Phi
Category of comment	number	%	number	%			
Man/social	354	77	304	72	3.00		
Exhibit access	289	63	239	57	3.66		
Other exhibit	227	50	173	41	6.34		
Body parts	280	61	309	73	14.82	p<0.005	0.03
Behaviour	301	66	363	86	49.49	p<0.005	0.56
Names	401	88	176	42	202.80	p<0.005	0.23
Affective attitudes_	193	42	229	54	13.1	p<0.005	0.02
emotive attitudes	143	32	199	49	23.70	p<0.005	0.04
Interpretative	443	97	400	95	1.59		
knowledge source	254	55	329	81	50.28	p<0.005	0.05
Environment	19	4	20	5	0.19		

Table 4.

Comparison of content of conversations about animal observations (category mentioned at least once in exchange) made by primary school groups at live animals and at animated models

Category of comment	zoo	n=459	dinosaurs	n=422	c 2 1df	Probab-ility	Phi
animal observations.	number	%	number	%			
Body parts	280	61	309	73	14.82	p<0.005	0.17
front end	77	17	113	27	13.00	p<0.005	0.02
dimensions	237	52	173	41	10.00	p<0.005	0.01
unfamiliar	32	7	59	14	11.66	p<0.005	0.01
disrupters	57	12	162	38	79.34	p<0.005	0.09
Behaviour	301	66	363	86	49.49	p<0.005	0.09
position	177	39	80	19	40.90	p<0.005	0.07
movement	130	28	249	59	84.44	p<0.005	0.05
feeding	54	12	127	30	45.25	p<0.005	0.10
attentions	115	25	182	43	32.14	p<0.005	0.05
Names	401	88	176	42	202.81	p<0.005	0.23
identity	318	69	147	35	104.69	p<0.005	0.12
category	220	48	85	20	75.00	p<0.005	0.09
compare	87	19	41	23	15.11	p<0.005	0.02
mistake	17	4	6	1	4.50		

Figure 1. Body parts segment of the network.